

What is claimed is:

1. A fixing band-tightening apparatus for forcibly nipping and deforming a projection of an annular fixing band loosely fitted to a workpiece having a shaft-shaped configuration so that a diameter of said fixing band is reduced to fix said fixing band to said workpiece, said fixing band-tightening apparatus comprising:

a holding section for gripping a shaft section of said workpiece at both ends in an axial direction to rotatably hold said workpiece in a circumferential direction in accordance with a driving action of a rotary driving source;

a stopper section arranged in a lateral direction substantially horizontal with respect to said holding section, for positioning said projection of said fixing band in said lateral direction except for a vertical direction; and

a band-tightening section for forcibly nipping said projection of said fixing band positioned by said stopper section to tighten said fixing band to said workpiece.

2. The fixing band-tightening apparatus according to claim 1, wherein said stopper section has a stopper block for making abutment against said projection of said fixing band to position said projection in said lateral direction except for said vertical direction, and said stopper block is provided displaceably in a substantially horizontal

direction and in a substantially vertical direction in accordance with a driving action of a first actuator and a second actuator.

5      3. The fixing band-tightening apparatus according to claim 2, wherein said stopper section is provided with a first sensor for detecting said projection before said projection of said rotating fixing band arrives at a band-tightening position in said lateral direction, and said stopper mechanism is operated on the basis of a detection signal outputted from said first sensor.

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15      4. The fixing band-tightening apparatus according to claim 2, wherein said stopper section is provided with a second sensor for detecting a fact that a first end of said stopper block abuts against said projection of said fixing band, and said stopper block is restored to an initial position on the basis of a detection signal outputted from said second sensor when said first end of said stopper block does not abut against said projection.

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25      5. The fixing band-tightening apparatus according to claim 4, wherein said second sensor is contained in said first end of said stopper block to make abutment against said projection of said fixing band, and it is arranged at a portion deviated in said substantially horizontal direction from a substantially central portion of said stopper block.

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6. The fixing band-tightening apparatus according to claim 2, wherein said stopper section is provided with a first sensor for detecting said projection before said projection of said rotating fixing band arrives at a band-tightening position in said lateral direction, and a second sensor for detecting a fact that a first end of said stopper block abuts against said projection of said fixing band respectively, and wherein detection positions to be sensed by said first sensor and said second sensor reside in a pin point H and a pin point I respectively, and said pin point H and said pin point I are arranged substantially in parallel at portions deviated by predetermined distances in said substantially horizontal direction from a substantially central portion of said fixing band.

7. The fixing band-tightening apparatus according to claim 1, wherein said band-tightening section is provided with a holding section for pressing and holding said projection of said fixing band positioned at a predetermined position, by means of a spring force of a spring member.

8. The fixing band-tightening apparatus according to claim 1, wherein said stopper section is provided with a tube for discharging air from a blow port to said fixing band.

9. The fixing band-tightening apparatus according to

claim 1, wherein said stopper section is provided with a pressing tab for pressing said fixing band in accordance with an action of a spring force of a spring member fastened to a first end.

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10. The fixing band-tightening apparatus according to claim 1, wherein:

10 said stopper section includes a first stopper mechanism for positioning said projection of said first fixing band, and a second stopper mechanism for positioning said projection of said second fixing band which is separated by a predetermined distance from said first fixing band;

15 said band-tightening section includes a first tightening mechanism for forcibly nipping said projection of said first fixing band, and a second tightening mechanism for forcibly nipping said projection of said second fixing band; and

20 said projections of said first and second fixing bands are tightened substantially simultaneously in a substantially simultaneously positioned state.

25 11. The fixing band-tightening apparatus according to claim 10, wherein said first fixing band is installed to a small diameter annular attachment section of a boot made of resin for covering a constant velocity universal joint, and said second fixing band is installed to a large diameter annular attachment section of said boot made of resin.

12. The fixing band-tightening apparatus according to claim 1, wherein:

said stopper section includes a first stopper mechanism for positioning said projection of said fixing band to be installed to a small diameter annular attachment section of a boot made of resin, and a second stopper mechanism for positioning said projection of said fixing band to be installed to a large diameter annular attachment section of said boot made of resin; and

said first stopper mechanism is provided with one or a plurality of tubes for discharging air toward said small diameter annular attachment section, while said second stopper mechanism is provided with a pressing tab for pressing said fixing band in accordance with an action of a spring force of a spring member.

13. A fixing band-tightening apparatus for fixing a boot made of resin to a constant velocity universal joint by installing a large diameter annular attachment section of said boot made of resin formed to have a hollow bellows-shaped configuration to a cup section of said constant velocity universal joint, installing a small diameter annular attachment section of said boot made of resin to a shaft section of an inner member, and forcibly nipping and constricting projections of annular fixing bands loosely fitted to said large diameter annular attachment section and

said small diameter annular attachment section respectively,  
said fixing band-tightening apparatus comprising:

a holding section for gripping said constant velocity  
universal joint at both ends in an axial direction to  
5 rotatably hold said constant velocity universal joint in a  
circumferential direction in accordance with a driving  
action of a rotary driving source; and

end-positioning mechanisms provided for said holding  
section, for positioning said annular attachment sections of  
said boot made of resin installed to said constant velocity  
universal joint at predetermined positions before forcibly  
10 nipping said projections of said fixing bands.

21/24. A fixing band-tightening apparatus for fixing a  
15 boot made of resin to a constant velocity universal joint by  
installing a large diameter annular attachment section of  
said boot made of resin formed to have a hollow bellows-  
shaped configuration to a cup section of said constant  
velocity universal joint, installing a small diameter  
20 annular attachment section of said boot made of resin to a  
shaft section of an inner member, and forcibly nipping and  
constricting projections of annular fixing bands loosely  
fitted to said large diameter annular attachment section and  
said small diameter annular attachment section respectively,  
25 said fixing band-tightening apparatus comprising:

a holding section for gripping said constant velocity  
universal joint at both ends in an axial direction to

rotatably hold said constant velocity universal joint in a circumferential direction in accordance with a driving action of a rotary driving source; and

5 a bellows section-pressing mechanism provided for said holding section, for pressing a bellows section of said boot made of resin disposed closely to said small diameter annular attachment section installed to said shaft section of said inner member of said constant velocity universal joint toward said large diameter annular attachment section before forcibly nipping said projection of said fixing band.

10 24/15. A fixing band-tightening apparatus for fixing a boot made of resin to a constant velocity universal joint by installing a large diameter annular attachment section of said boot made of resin formed to have a hollow bellows-shaped configuration to a cup section of said constant velocity universal joint, installing a small diameter annular attachment section of said boot made of resin to a shaft section of an inner member, and forcibly nipping and  
15 constricting projections of annular fixing bands loosely fitted to said large diameter annular attachment section and said small diameter annular attachment section respectively, said fixing band-tightening apparatus comprising:

20 a holding section for gripping said constant velocity universal joint at both ends in an axial direction to  
25 rotatably hold said constant velocity universal joint in a circumferential direction in accordance with a driving

action of a rotary driving source;

end-positioning mechanisms provided for said holding section, for positioning said annular attachment sections of said boot made of resin installed to said constant velocity universal joint at predetermined positions before forcibly nipping said projections of said fixing bands; and

a bellows section-pressing mechanism provided for said holding section, for pressing a bellows section of said boot made of resin disposed closely to said small diameter annular attachment section installed to said shaft section of said inner member of said constant velocity universal joint toward said large diameter annular attachment section before forcibly nipping said projection of said fixing band.

16. The fixing band-tightening apparatus according to claim 13, wherein said end-positioning mechanism includes a large diameter side end-positioning mechanism for positioning said large diameter annular attachment section of said boot made of resin installed to said cup section of said constant velocity universal joint at said predetermined position.

17. The fixing band-tightening apparatus according to claim 13, wherein said end-positioning mechanism includes a small diameter side end-positioning mechanism for positioning said small diameter annular attachment section of said boot made of resin installed to said shaft section



of said inner member of said constant velocity universal joint at said predetermined position.

5 18. The fixing band-tightening apparatus according to claim 13, wherein said end-positioning mechanism includes a large diameter side end-positioning mechanism for positioning said large diameter annular attachment section of said boot made of resin installed to said cup section of said constant velocity universal joint at said predetermined position, and a small diameter side end-positioning mechanism for positioning said small diameter annular attachment section of said boot made of resin installed to said shaft section of said inner member of said constant velocity universal joint at said predetermined position.

10 19. The fixing band-tightening apparatus according to claim ~~16~~<sup>14</sup>, wherein said large diameter side end-positioning mechanism has an actuator, and a cylindrical collar provided movably back and forth with respect to said cup section of said constant velocity universal joint in accordance with a driving action of said actuator, and wherein a first end of said collar abuts against said large diameter annular attachment section temporarily positioned on said cup section, and thus said large diameter annular attachment section is positioned at said predetermined position.

20 25 18. The fixing band-tightening apparatus according to

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claim ~~14~~, wherein said small diameter side end-positioning  
mechanism has first and second actuators, a chuck member  
provided displaceably in a substantially vertical direction  
and in a substantially horizontal direction in accordance  
5 with a driving action of said first and second actuators, a  
pair of support members provided to be capable of making  
approach or separation in accordance with a driving action  
of said chuck member, support blocks provided for said pair  
of support members, for rotatably supporting said shaft  
10 section of said inner member, and circular arc-shaped  
projections provided for said support blocks, for making  
protrusion by predetermined lengths in said axial direction  
of said shaft section, and wherein ends of said circular  
arc-shaped projections abut against said small diameter  
15 annular attachment section which is temporarily positioned,  
and thus said small diameter annular attachment section is  
positioned at said predetermined position.

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21. The fixing band-tightening apparatus according to  
claim ~~14~~, <sup>21</sup> wherein said bellows section-pressing mechanism  
includes an actuator, and a pressing plate provided movably  
back and forth in directions inclined by a predetermined  
angle with respect to an axis of said shaft section of said  
inner member in accordance with a driving action of said  
25 actuator, and wherein a flat surface section of said  
pressing plate enters a boundary portion between said small  
diameter annular attachment section and said bellows section

to press said bellows section toward said large diameter annular attachment section.

25 22. The fixing band-tightening apparatus according to claim 15, wherein said end-positioning mechanism and said bellows section-pressing mechanism are provided to make operation substantially simultaneously.

19 23. The fixing band-tightening apparatus according to claim 17, wherein an annular member is externally fitted to said collar, and said collar and said constant velocity universal joint are provided rotatably in an integrated manner by the aid of a pair of rollers to make engagement with said annular member.

23 24. The fixing band-tightening apparatus according to claim 21, wherein said actuator is connected via an attachment member to a support pillar for rotatably supporting a drive shaft as said shaft section of said inner member, and it is arranged to be inclined by a predetermined angle with respect to an axis of said drive shaft.

20 20 25. The fixing band-tightening apparatus according to claim 19, wherein said collar surrounds pinching blocks of a chuck mechanism for gripping said cup section of said constant velocity universal joint, and it is provided movably back and forth along an axis of said pinching

blocks.

5        26. A fixing band-tightening method for forcibly nipping and deforming a projection of an annular fixing band loosely fitted to a workpiece having a shaft-shaped configuration so that a diameter of said fixing band is reduced to fix said fixing band to said workpiece, said fixing band-tightening method comprising the steps of:

10        integrally rotating, in a circumferential direction of said workpiece, said fixing band loosely fitted to a shaft section of said workpiece with a clearance intervening therebetween, in accordance with a driving action of a rotary driving source;

15        temporarily positioning a projection in a lateral direction except for a vertical direction by allowing a stopper block to abut against said projection of said rotating fixing band;

20        positioning said projection at a predetermined position by pressing said temporarily positioned projection by means of a holding section, and deenergizing said rotary driving source to stop said rotation; and

25        forcibly nipping said projection held at said predetermined position by said holding section so that said fixing band is tightened and fixed to said workpiece.

27. A fixing band-tightening method for a boot for a constant velocity universal joint for tightening and

constricting a fixing band with respect to said boot to be installed to said constant velocity universal joint, said method comprising the steps of:

5 rotatably holding said constant velocity universal joint installed with said boot made of resin with its axis as a center of rotation with respect to a fixing band-tightening apparatus;

10 loosely fitting said fixing band to a band-mounting groove of at least any one of a large diameter annular attachment section and a small diameter annular attachment section of said boot made of resin to temporarily assemble said fixing band;

15 integrally rotating said boot made of resin and said fixing band in a state in which a frictional coefficient between said loosely fitted fixing band and said boot made of resin is increased by means of a frictional coefficient-increasing mechanism formed for said band-mounting groove, in accordance with a driving action of a rotary driving source provided for said fixing band-tightening apparatus; and

20 tightening and constricting said fixing band by positioning, at a predetermined position, a projection of said fixing band rotating together with said boot made of resin, and forcibly nipping said projection in said positioned state.

25 28. The fixing band-tightening method for said boot

for said constant velocity universal joint according to claim 27, wherein said projection of said fixing band is forcibly nipped in a state of being positioned at a position in a substantially horizontal direction.

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29. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 27, wherein said frictional coefficient-increasing mechanism comprises a first small projection and a second small projection which are separated from each other with an annular groove formed at a substantially central portion of said band-mounting groove intervening therebetween.

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30. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 27, wherein said frictional coefficient-increasing mechanism comprises a first small projection and a second small projection which protrude upwardly from an annular groove formed at a substantially central portion of said band-mounting groove.

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31. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 27, wherein said frictional coefficient-increasing mechanism comprises a small projection formed on a wall surface on a side of a bellows section of said band-mounting groove.

32. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 27, wherein said frictional coefficient-increasing mechanism comprises a small projection formed on a wall surface on a side opposite to a wall surface on a side of a bellows section of said band-mounting groove.

33. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 29, wherein said first and second small projections are composed of a plurality of individuals which are separated from each other by predetermined spacing distances in a circumferential direction.

34. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 29, wherein said first and second small projections are formed continuously in said circumferential direction.

35. The fixing band-tightening method for said boot for said constant velocity universal joint according to claim 31, wherein said small projection has a substantially triangular configuration as viewed from an upper position, and it is formed to have a tapered configuration in which a vertical sectional configuration substantially perpendicular to a circumferential direction has an inclined surface

inclined toward said fixing band.

36. A constant velocity universal joint apparatus comprising:

5 a drive shaft;

a tripod type constant velocity universal joint connected to a first end of said drive shaft with a steel belt having an overlapped portion to be irradiated with a laser beam to effect welding and fusion so that said steel belt is fixed to a boot made of rubber; and

10 a bar field type constant velocity universal joint connected to a second end of said drive shaft with a projection of a fixing band to be forcibly nipped so that said fixing band is fixed to a boot made of resin.